

WHAT IS CLAIMED IS:

1. A method for forming a film of aluminum oxide, comprising sputtering a target containing aluminum in a gas containing fluorine atoms.

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c⁺ 2. The method for forming a film of aluminum oxide according to Claim 1 wherein the gas contains oxygen.

10 c⁺ 3. The method for forming a film of aluminum oxide according to Claim 1 wherein the content of fluorine gas added in the gas is 0.2% to 20%.

15 4. The method [for forming a film of aluminum oxide] according to Claim [3] wherein the gas is at least a gas selected from the group consisting of F₂, NF₃, SiF₄, CF₄, C₂F₂ and C₄F₈.

20 c⁺ 5. The method for forming a film of aluminum oxide according to Claim 1 wherein the gas contains at least one of CF₄ and NF₃, and H₂O.

25 6. The method for forming a film of aluminum oxide according to Claim 5 wherein the gas further contains oxygen and helium.

7. The method for forming a film of aluminum

oxide according to Claim 1 wherein the gas contains at least one of the gases of CF_4 and NF_3 , and H_2O , O_2 and He.

5 8. The method for forming a film of aluminum oxide according to Claim 1 wherein the film of aluminum oxide is formed while monitoring the content of fluorine in the gas.

10 9. The method [for forming a film of aluminum oxide] according to Claim 1 wherein the [aluminum oxide film] is formed on a light-transmissive insulating substrate.

15 10. The method [for forming a film of aluminum oxide] according to Claim 9 wherein the light-transmissive insulating substrate is quartz or fluorite.

20 11. A film of aluminum oxide comprising fluorine.

12. The film of aluminum oxide according to Claim 11 wherein the content of the fluorine is 2.0% by weight or more.

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13. The film of aluminum oxide according to Claim 11 wherein the content of hydroxyl groups is 0.5% by

weight or more.

14. The film of aluminum oxide according to Claim
11 wherein the content of the fluorine is 2.0% by
5 weight or more and the content of hydroxyl groups is
0.5% by weight or more.

15. Optical parts in which a film of aluminum
oxide is formed on a light-transmissive insulating
10 substrate, wherein the aluminum oxide film is the
aluminum oxide film according to Claim 11.

16. A film of aluminum oxide having the ratio of
NE to NA in the aluminum oxide film wherein the ratio
15 satisfies the following relation:

$$1.55 < NE/NA < 1.85$$

where NA is the number of aluminum atoms and NE is the
number of the atoms other than aluminum atoms contained
in the film.

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17. A film of aluminum oxide according to Claim
16 wherein the ratio of NO to NA in the aluminum oxide
film wherein the ratio satisfies the following
relation:

25 $1.55 < NO/NA < 1.75$

where NA is the number of aluminum atoms and NO is the
number of oxygen atoms contained in the film.

18. A film of aluminum oxide according to Claim
17 wherein the proportion of oxygen atoms bound to
aluminum atoms is 95% or more and the proportion of
oxygen atoms bound to hydrogen atoms is 2.0% or more in
5 the film.

19. Optical parts in which a film of aluminum
oxide is formed on a light-transmissive insulating
substrate, wherein the film of aluminum oxide is the
10 aluminum oxide film according to Claim 16.

20. A method for forming a sputtering thin film
in which a plasma is generated by applying a high
frequency voltage to a cathode electrode in a vacuum
15 vessel, ions in the plasma are accelerated and collided
to a target to make aluminum or alumina to be ejected
from the target and a thin film of alumina is formed on
the substrate, comprising forming the thin film of
alumina by adding fluorine or a gas containing fluoride
20 compounds into a sputtering gas.

21. The method for forming a sputtering thin film
according to Claim 20 wherein the sputtering gas is
argon and/or oxygen.
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× 22. The method for forming a sputtering thin film
according to Claim 20 wherein the amount of the gas

containing fluorine or fluoride compounds is within 0.5 to 20% of the sputtering gas.

23. The method for forming a sputtering thin film
5 according to Claim 20 wherein the fluoride compounds are one or a plurality of the compounds selected from F_2 , NF_3 , SiF_4 , CF_4 , C_2F_2 or C_4F_8 .

24. The method for forming a sputtering thin film
10 according to Claim 20 wherein the thin film of alumina contains fluorine.

25. The method for forming a sputtering thin film
according to Claim 20 wherein means in which repeating
15 self-vias is temporarily set near the earth potential during sputtering discharges is used and a gas supplemented with fluorine or fluoride compounds is introduced by synchronizing with a self-vias near the earth potential.

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26. The method for forming a sputtering thin film
according to Claim 25 wherein means in which self-vias
potential is set near the earth potential during
sputtering discharges is used and the repeating
25 frequency is 0.1Hz or less.

27. A system for forming a sputtering thin film

in which a plasma is generated by applying a high frequency voltage from a high frequency power source to a cathode electrode provided in a vacuum vessel, ions in the plasma are accelerated and collided to a target
5 provided in the vacuum vessel to make aluminum or alumina to be ejected from the target and a thin film of alumina is formed on the substrate, the thin film of alumina being formed by adding fluorine or gases containing fluoride compounds into a sputtering gas.

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28. The system for forming a sputtering thin film according to Claim 27 wherein the sputtering gas is argon and/or oxygen.

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29. The system for forming a sputtering thin film according to Claim 27 wherein the amount of the gas containing fluorine or fluoride compounds is within 0.5 to 20% of the sputtering gas.

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30. The system for forming a sputtering thin film according to Claim 27 wherein the fluoride compounds are one or a plurality of compounds selected from F_2 , NF_3 , SiF_4 , CF_4 , C_2F_2 or C_4F_8 .

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31. The system for forming a sputtering thin film according to Claim 27 wherein means in which repeating self-vias is temporarily set near the earth potential

during sputtering discharges is used and a gas supplemented with fluorine or fluoride compounds is introduced by synchronizing with a self-vias near the earth potential.

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32. The system for forming a sputtering thin film according to Claim 31 wherein means in which self-vias potential is set near the earth potential during sputtering discharges is used and the repeating

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frequency is 0.1Hz or less.